DOCUMENT RESUME

ED 262 971 SE 046 183

TITLE	A Reduced-Content 16+ Syllabus in Physics. A Working Paper Prepared for the Physics Education Joint Committee of the Royal Society and Institute of Physics.
INSTITUTION	Institute of Physics, London (England).; Royal Society, London (England).
PUB DATE	Feb 84
NOTE	23p.
PUB TYPE	Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	*Course Content; *Course Descriptions; Foreign Countries; *Physics; Science Curriculum; Science Education; Secondary Education; *Secondary School Science
IDENTIFIERS	*Great Britain

ABSTRACT

After publication in 1982 of the Royal Society report "Science Education 11-18 in England and Wales," the Physics Education Joint Committee of the Royal Society and Institute of Physics was established. A working party of this Joint Committee has now produced this reduced-content 16+ syllabus in physics. The main intention of the working party was to produce suggestions for an essential minimum core syllabus in physics for children of all abilities, a core which would be fitted into a coordinated science curriculum for secondary years. The syllabus consists of: (1) a foreword outlining the purpose of the syllabus; (2) an introduction, outlining the aims of physics education, offering several suggestions (such as emphasizing physics processes and applications), and explaining other areas; and (3) the syllabus. The syllabus is set in three columns. The left-hand column outlines the broad topic areas, the middle column provides a commentary on the treatment of the topic for low ability children, and the right-hand column deals with modifications and additional content required for an essential core physics syllabus for General Certificate of Education (GCE) and Certificate of Secondary Education (CSE). An appendix lists illustrative applications appropriate to the various sections of the syllabus. (JN)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED262971

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)
☑ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

A reduced-content 16+ syllabus in physics

A Working Paper prepared for the
Physics Education Joint Committee of the Royal Society and Institute of Physics

February 1984

SE 046 183

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Jill A. Nelson
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

JOINT ROYAL SOCIETY/INSTITUTE OF PHYSICS COMMITTEE FOR PHYSICS EDUCATION

REPORT OF THE WORKING PARTY ON REDUCTION OF 16+ SYLLABUSES IN PHYSICS

1. FOREWORD

This report has been produced as a result of the 1982 Royal Society report "Science Education 11-18 in England and Wales".

The Royal Society report suggested that all children should be expected to spend something like 20% of their curriculum time (8 or 9 periods out of a weekly 40) on science, at least in their fourth and fifth secondary years.

It has been suggested by the DES, ASE and in the SSCR consultative paper that prior to the fourth and fifth years science should have the following time allocations:

10% of total curricular time for students aged 11-13
15% of total curricular time for students aged 13-14

The Working Party has accepted these time allocations and expects that about one third of the time devoted to science should be allocated to physics and closely related subjects. The core syllabus discussed below in the report would occupy about 60% of this time allocation.

The Working Party feels that some of the remaining time should allow teachers the freedom to pursue the ideas and interests of their pupils in physics and allow time for the more difficult concepts to be considered more fully with more applications. The Working Party stresses that the suggested core does not prevent any teacher from including additional material as required but any examination syllabus devised on the basis of this core content should not use all of the remaining 40% of the time allocation for the additional material.

The Working Party considers that pupils are not at present given sufficient time and opportunity to digest information and to practise the application of their knowledge to the solution of realistic problems.

2. INTRODUCTION

2.1 The main intention of the Working Party was to produce suggestions for an essential minimum core syllabus in physics for children of all abilities. It will, of course, have to be fitted into a coordinated science curriculum.

2.2 The methods of assessment and examination were not considered.

2.3 The 'Core of Content' from the GCE and CSE Boards' Joint Council for 16+ National Criteria in physics has been used as a pattern by the Working Party in setting out its suggested syllabus.

2.4 The Working Party is in sympathy with all the general aims given in the Secondary Science Curriculum Review consultative paper 'Science Education 11-16: Proposals for action and consultation' pp5-6 but would wish particularly to emphasise the following of the paper's aims as applied to the physics part of a broader and more balanced approach to science studies in schools:

Schools should be able to provide at appropriate stages of a five year programme adequate opportunities for all students to

1. explore the nature of the biological and physical environment through observation, experiment and systematic inquiry;

2. develop the ability to design and carry out experiments, evaluate evidence and solve problems;

3. use their knowledge of science to design and develop solutions to technological problems, to test and evaluate those solutions and to cost such exercises;

4. study key concepts that are essential to an understanding of the part science and technology play in a post-industrial and technological society;

The Working Party feels that the emphasised aims are appropriate for pupils of <u>all</u> abilities but other aims, for example, "gain some understanding of the historical and contemporary significance of scientific principles and theories" are of particular importance for the most able.

2.5 Whilst integrating the core syllabus below into a school physics curriculum the Working Party hopes that:

(a) Emphasis would be placed on the <u>processes</u> of physics rather than the acquisition of knowledge.

(b) Practical applications, experimental design and social implications of physics would feature strongly.

(c) Whatever teaching methods are employed the important role of problem solving in the processes of technological development would be made clearly evident.

(d) Wherever possible areas of knowledge bordering on physics such as astronomy, earth sciences, applied sciences and technology would be included in the teaching.

(e) The development of the curriculum would take account of the mathematical understanding of pupils at each stage.

(f) Knowledge of general principles underlying the design of experiments and evidence of practical experience in carrying out experiments is expected but detailed information on particular experiments should not be examined. E.g. most teachers use the smoke cell to investigate Brownian Motion. Examination questions should concentrate on the nature and significance of Brownian Motion and <u>not</u> expect pupils to recite the details of the experimental equipment.

2.6 In setting out the syllabus the Working Party has made both positive and negative suggestions (negative in the sense of recommending that certain things should not be examined in any part of the physics syllabus). The negative suggestions are inserted between square brackets [ ] .
In making these suggestions the Working Party has been guided by the conviction that current physics syllabuses at all levels are over-loaded and in certain areas are conceptually too difficult.

2.7 The syllabus has been set out in three columns. The left hand column outlines the broad topic areas, the middle column provides a commentary on the treatment of the topic for low ability children and the right hand column deals with modifications and additional content required for an essential core physics syllabus for GCE and CSE. An appendix lists illustrative applications appropriate to the various sections of the syllabus. These applications are given essentially to indicate the level of approach that is being recommended for appropriate ability groups. The Working Party is anxious to emphasise that under no circumstances should the list be regarded as prescriptive.

3. THE SYLLABUS

	TOPIC	COMMENTARY ON TREATMENT FOR PUPILS OF LOW ABILITY	COMMENTARY ON ADDITIONAL CONTENT FOR ESSENTIAL PHYSICS SYLLABUS FOR GCE/CSE
A	MATTER		
	(i) States of matter	Simple experiences of solid to liquid and liquid to gas changes including evaporation and qualitative heat transfer. [No mention of latent heat, specific heat etc.]	Atomic and Molecular structure of solids, liquids and gases. Kinetic theory used to explain i)Fluid compressibility, ii)Variation of pressure and volume of a gas at constant temperature, iii)Variation of pressure and temperature at constant volume, iv)changes of state, v)diffusion. Absolute zero at -273°c and Kelvin temp. scale [No gas laws calculations]
	(ii) Charge	Applications of static charges only, eg., nylon carpets etc. Consideration of moving charge in a circuit is not necessary.	Two types of charge - excess electrons, depletion of electrons, ions. Attraction of unlike charge, repulsion of like charge. Flow of charge is an electric current.
	(iii) Basic magnetic, electrical, thermal and elastic properties of matter	Experience of magnetic materials. Permanent magnets. Thermal and electrical insulators and conductors. Expansion and contraction of materials. Stretching springs and copper wire. Bending and building frameworks.	Magnetic field of a bar magnet, the Earth, the compass' behaviour in a magnetic field. Differential expansion, forces involved. Anomalous expansion of water. Force/extension graphs - interpretation. Simple calculations on elasticity. Semiconductors interpreted as materials between conductors and insulators.
	(iv) Radioactivity	How to detect radiation. How to protect yourself. Use of radioactivity. The problems and advantages of the use of nuclear appliances.	Atomic structure in terms of neutrons, protons and electrons. Atomic and Mass Numbers. Isotopes. Comparison of Fission and Fusion. Background radiation, half-life decay graphs and simple calculations. Relative ionisation of α, β, γ and n. Relative penetration of α, β, γ and n through air, paper, Aluminium and Lead.

B	**ENERGY**		
	(i) Forms and interconversion of energy and its relationship to work	As many examples as possible, E.g. Malvern conversion kit. [NOT quantitative.]	Qualitative understanding of kinetic and potential energy. Law of Conservation of Energy. The Energy crisis in relation to a)World demand, b)energy resources, c)energy saving.
	(ii) Concepts of work and power	Work = force x distance Using the bicycle ergonometer. Power = work in a second.	Power = Work Done/Time Taken.
	(iii) Energy transfer	Examples from heat, sound and light. Radio. Radiation, convection and conduction.	Temperature and Heat Energy. [No heat energy calucations.] Efficiency = Work output/Work input. Radiation - surface condition effect on emission and absorption. Convection currents in fluids in terms of density change. Conduction through metals and non-metals. Air and water-poor conductors. Domestic insulation.
	(iv) Waves		Waves propagate energy [No need to distinguish standing and progressive waves.] Electromagnetic waves - spectrum, speed, no medium required. Sound waves - speed, medium required. Reflection, refraction caused by change of velocity at an interface. Principle of critical angle and total internal reflection. Experimental demonstrations of diffraction. [No consideration of interference] Frequency, wavelength, their relationship to colour/pitch velocity = frequency x wavelength. Amplitude and a qualitative relation to brightness and loudness.
C	**INTERACTIONS**		
	(i) Force and its effects producing changes in size and shape.	Qualitative effects only on different materials	Distinctions between vectors and scalars [No vector analysis.]

(ii) Effect of a force on the motion of a body	Qualitative effects only but include friction.	force = mass x acceleration acceleration=(final-initial velocity)/time. uniform velocity = distance/time. average velocity =(initial+final velocities)/2 Use of above equations Interpretation of distance-time and velocity-time graphs, gradient. [No consideration of area under graph.] [No momentum.]
(iii) Balancing forces	[NOT quantitative] [NO Newton's Laws] As many illustrative examples as possible.	Pressure = Force ÷ Area. An appreciation that pressure increases with fluid depth. [NOT Pressure = density x acceleration of free fall x depth.] Weight as a force. The effect of gravity on mass. Magnetic, electrostatic, gravitational forces act at a distance and decrease in magnitude with distance, qualitatively.
(iv) Using electricity	Heating, lighting and magnetic effects. Making motors, generators etc. Fuses and safety in the home including wiring a plug and consideration of 'short circuits'. Paying for electrical energy.	Currents at junctions. Ohm's Law. Series and parallel resistors. P.d sum round a circuit. Relationship between temperature and resistance. Power = current x voltage, Energy = power x time. Design and uses of ring/spur circuits. AC and DC compared using an oscilloscope. Magnetic field of a wire and hence of a solenoid. Force acting on a conductor in a magnetic field. Direction and factors affecting strength of force. EMF from moving wire in a field, or changing magnetic field.
D BASIC USES OF ELECTRONICS		
(i) Everyday electronics	Experience of the use of electronic components in circuits. [NOT an understanding of the construction or the physics of discrete components.]	Power supply - Transformer, bridge, rectifier, smoothing capacitor, zener diode Transistor as a Switch - LDR, Thermistor with potential divider Integrated Circuit Operational Amplifier as an amplifier. All discrete components treated as black boxes

(ii) Electronics in Society	The role of robotics, assisting the handicapped and other examples.	The consequences of miniaturisation. The applications of electronics - automation - limitations of automation - social consequences - financial implications
E PHYSICAL QUANTITIES		
(i) Familiarisation with units	Units of mass, length, time, temperature, current, area, volume, speed, force, voltage and resistance, energy, power. The following prefixes: M-mega, k-kilo, c-centi, m-milli, μ-micro.	Density, pressure, electrical capacitance.
(ii) Measurement of units	Measurement of units of length, time, temperature, current, area, volume.	Force, density, Pd, EMF, electrical resistance, energy, power.

4. APPENDIX

REFERENCE TO TOPIC:	ILLUSTRATIVE APPLICATIONS
A. MATTER	
(i) States of matter	Comparison of pneumatic and hydraulic brakes. The bicycle/foot pump. Pressure cooker, avoiding exposure of spray cans to sunlight, car tyre pressures after long motorway journey.
(ii) Charge	Relate to lightning, discharging oil tankers during load/unloading, dust extractors at power stations.
(iii) Basic magnetic electrical thermal and elastic properties of matter	Reliance of computer/video cassette tapes on magnetism. Magnetic soap holders, door latches. Bimetal strip thermostat. Fish surviving winter in frozen pond. Relate to spring balance-force measurement, displacement of large structures such as bridges.
(iv) Radioactivity	Applications include γ radiography, Co^{60} cancer treatment, isotope trace techniques, sterilization of syringes. Nuclear reactor. Atomic weapons.
B. ENERGY	
(i) Forms and interconversion of energy and its relationship to work	This topic should be related to work on efficiency in machines.
(ii) Concepts of work and power	Apply to machines such as pulley, transformer. Consider the implications of car engine efficiency to oil usage. Relate to electric cars.
(iii) Energy Transfer	Hot water systems, hot air/radiator heating, double glazing, cavity wall/loft insulation, solar panels, vacuum flask, pipe lagging, ablative tiles on space shuttle.

(iv) Waves	The principle of one optical instrument using converging lenses. Optical fibres.
C. INTERACTIONS	
(i) Force and its effects producing changes in size and shape	Examples of vectors and scalars.
(ii) Effect of a force on the motion of a body	Include free fall. The dual nature of friction, streamlining, energy saving.
(iii) Balancing forces	Relate to air pressure, altimeter. Aneroid barometer. Car brakes, hydraulic pressure as examples. Weight on moon. TV/Radio signals - reception has limited range. TV magnetic field destroying Video/cassette tapes.
(iv) Using electricity	Eg. light bulbs, immersion heaters, thermostat, buzzers, bells, hair driers, electric fires, relays. Louspeakers, motors, relays. Generators, radio/tv reception. Transformer in relation to energy saving and safety, overhead cables, low voltage supplies eg as in battery chargers, model railways etc.
D. BASIC USES OF ELECTRONICS	
(i) Everyday electronics	As used in computers, radios, portable cassettes. Automatic switching of street lights, burglar alarms, tape recorders, fire alarm. Stereo systems, any audio/video system.

(ii) Electronics in Society	Study through the consideration of computer automation and/or robotics, Computer Aided Design (eg. IC design) Robot automation (eg. leak detection) Non-robotic automation (eg. assembly lines) Computer applications (eg. bar codes) Computer games Domestic applications (eg. TV remote control)
E. PHYSICAL QUANTITIES (i) Familiarisation with units (ii) Measurement of units	

Membership of Working Party

Mrs J Fisher (Chairman)

Dr B Gunnell

Mrs R Hodson

Mr M G Ebison (Secretary)